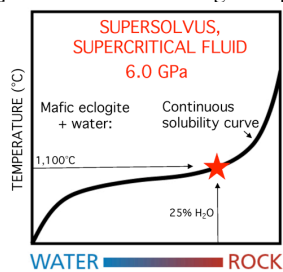


Supercritical fluid controls on mantle f_{O_2} with diamond and carbonic acid

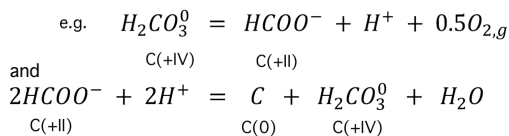
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Fluids in the mantle can no longer be regarded as simple molecular COH fluids. Abundant evidence from fluid inclusions in diamonds and experimental studies of eclogite and peridotite solubilities demonstrate the complex solute chemistry of mantle fluids [1 - 3]. Recent advances in modelling deep Earth fluids by calibrating with high pressure and temperature rock solubilities referring to subsolidus conditions [4] now enable modelling of supercritical fluids.



A key aqueous species at pressures between 3.0 and 10.0 GPa is carbonic acid: H_2CO_3 - a molecule that geochemists have long forgotten [5]. CO_2 is unimportant in high pressure fluids. Instead, the f_{O_2} of fluids in equilibrium with diamond is controlled by redox equilibria in the fluid between inorganic and organic C-species with high molalities:



The above reactions model the control of f_{O_2} measured in a fluid in equilibrium with a mafic eclogite at $QFM - 2.7$ [6], without any significant methane in the fluid. In summary, inorganic and organic metal complexes give high solubilities in mantle fluids with complex chemistry. Modelling of supercritical mantle fluids can now proceed from water-rich to silicate-rich fluid compositions. The high concentrations of C-species such as H_2CO_3 and $HCOO^-$ can control the f_{O_2} during the fluid-rock interactions involved in mantle metasomatism and diamond formation.

[1] Weiss et al. (2015) *Nature* **524**, 339-342. [2] Kessel et al. (2005) *EPSL* **237**, 873-892. [3] Kessel et al. (2015) *CMP* **169**, 37-56. [4] Huang & Sverjensky (2019) *GCA*, in press. [5] Pan & Galli (2016) *Sci. Adv.* **2**, e1601278. [6] Elazar et al. (2019) *GCA*, in press.